mi

TF 2337

Automatic Distortion Meter

INSTRUCTION MANUAL

MP MASTER
MA23642

MARCONI INSTRUMENTS LIMITED

MANUAL CHANGES

for

AUTOMATIC DISTORTION METER TF 2337

The following changes refer to current production.

Page 3. Add new paragraph

The TF 2337 Automatic Distortion Meter is particularly suitable for SINAD ratio measurements of Mobile Radio Receivers. Since no re-adjustment to the TF 2337 is required to compensate for changes in receiver output levels, production test times can be improved. (Measuretest No. 008 refers).

The internal filters are not usable in this application, however, a suitable 1 kHz band stop filter can be fitted externally.

Marconi Instrument 4 kHz Band Stop Filter Type 54497-031 is available as an optional accessory.

Page 4. 1.2 DATA SUMMARY

Fundamental Frequency.
✓ Amend last line to read -
"30 Hz to 10 kHz using external filter facility"

Add new parameter -
✓ "Total Bandwidth Upper -3 dB limit nominally 100 kHz"

Distortion Measurement
✓ Amend Accuracy claim to read -
"Accuracy ±5% f.s.d.

Level Measurement
✓ Amend Frequency Response claim to read -
"20 Hz to 50 kHz ± 0.5 dB (1 kHz reference)

✓ Amend Accuracy claim to read
"± 5% f.s.d. in each range"

Input Impedance
Amend to read -
✓ "100 kΩ ±10% etc....."

1.3 ACCESSORIES

Add "Optional Accessories

100 Hz High Pass Filter 54497-011
7 kHz High Pass Filter 54497-021
1 kHz Band Stop Filter 54497-031

Alternative external filters available to order"

Page 16. 4.4.4 Adjustment of Distortion Amplifier

✓ Amend first line to read -
"Connect a 600 Ω unbalanced etc....."

A copy of MEASURETEST (Notes on Instrument Applications) No. 008 referring to SINAD Ratio Measurements using the TF 2337 is attached.

EB 2337
C2 - 3/73

Manual Changes

for

AUTOMATIC DISTORTION METER TF2337

Changes and errata. The following changes refer to current production. For maintenance purposes the type called for in the original handbook may be used.

Page 22 — Amend C101 M.I. Part Number to read - FPP/MXT 1P1.

Page 24 — Amend C203 M.I. Part Number to read - FPP/MXT 1P1.

Amend description and M.I. Part Number of D201 as follows :-

D201	Diode Stack - Silcon 1.5A	FPP/151850

Amend D202 to read D203 as follows :-

D203	Zener Diode 7.5V to 10.0V 200mA	FPP/RD9A

Add D202 as follows :-

D202	Diode Stack - Silicon 1.5A	FPP/151850R

Circuit Diagram Amend D201 to indicate 2 parellel rectifying stacks D201 and D202.

MARCONI INSTRUMENTS LIMITED

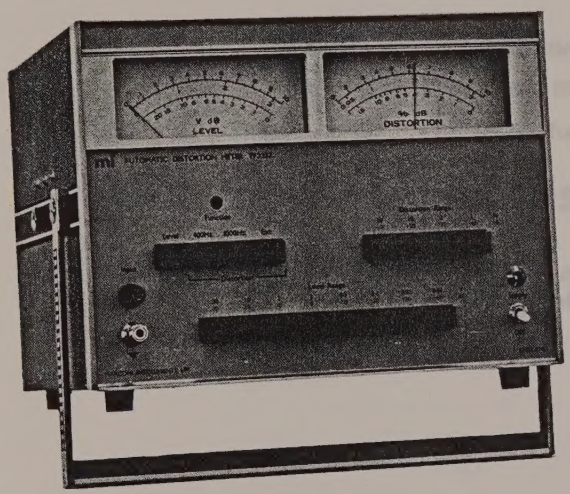
MEASURETEST
Notes on Instrument Applications

008

SINAD RATIO MEASUREMENTS USING THE AUTOMATIC DISTORTION FACTOR METER TF 2337

By A.M. Rudkin B.Sc (Eng) Hons.

SINAD ratio measurements form an important part of Mobile Radio Receiver testing especially during production. The Marconi Instruments Automatic Distortion Factor Meter, type TF 2337, can be used to speed up the test time since it requires no readjustment to compensate for a change in the receiver output level.



A typical SINAD ratio measurement set-up is shown in fig 1 and the figures given are based on the specifications laid down in MPT 101 issued by the British Post Office Telecommunications Headquarters. The Automatic Distortion Factor Meter indicates directly, in dB, the ratio of Signal + Noise + Distortion to Noise + Distortion (SINAD ratio) and a second meter movement indicates the receiver output level in volts.

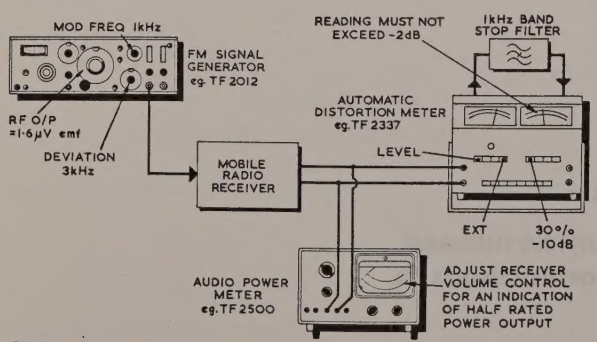

MOD FREQ 1kHz
FM SIGNAL GENERATOR eg. TF 2012
RF O/P ≈1·6μV emf
DEVIATION 3kHz
MOBILE RADIO RECEIVER
READING MUST NOT EXCEED -2dB
1kHz BAND STOP FILTER
AUTOMATIC DISTORTION METER eg. TF 2337
LEVEL
EXT
30% -10dB
AUDIO POWER METER eg. TF 2500
ADJUST RECEIVER VOLUME CONTROL FOR AN INDICATION OF HALF RATED POWER OUTPUT

FIG 1

Fig 1 shows a power meter connected to the receiver output but since the Automatic Distortion Factor Meter also indicates voltage level it is possible to dispense with the power meter and use a dummy load instead (as shown in fig 2). When used in this way the receiver volume control should be set for an indicated voltage level of $\sqrt{\frac{1}{2}P_R R_L}$ volts where P_R is the rated power output of the receiver in watts and R_L is the rated load impedance in ohms.

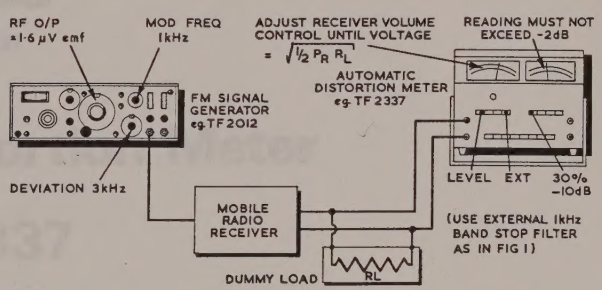

RF O/P ≈1·6μV emf
MOD FREQ 1kHz
ADJUST RECEIVER VOLUME CONTROL UNTIL VOLTAGE = √½ P_R R_L
READING MUST NOT EXCEED -2dB
AUTOMATIC DISTORTION METER eg. TF 2337
FM SIGNAL GENERATOR eg. TF 2012
DEVIATION 3kHz
LEVEL
EXT
30% -10dB
MOBILE RADIO RECEIVER
(USE EXTERNAL 1kHz BAND STOP FILTER AS IN FIG 1)
DUMMY LOAD
RL

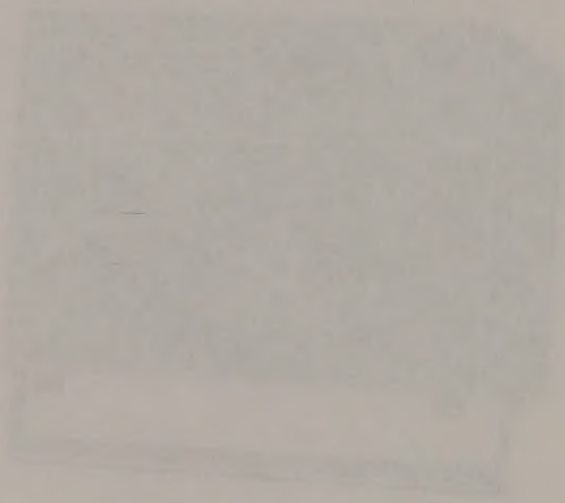
FIG 2

A 1kHz band stop filter is connected to the Automatic Distortion Factor Meter to reject a narrow band of frequencies around 1 kHz whilst allowing the noise and distortion products to pass with very little attenuation. A suitable 1 kHz band stop filter may be ordered from Marconi Instruments under the code number 54497-031. Other frequencies are available to special order. The internal 1 kHz high pass filter should not be used for SINAD ratio measurements because it will reject a considerable proportion of the noise and will consequently introduce appreciable error.

The advantage of using the Automatic Distortion Factor Meter in preference to a manually tuned instrument (such as the Marconi Instruments Distortion Factor Meter, TF 2331) is that the operator would never need to touch the instrument during the test. This naturally leads to a significant reduction in test time and by using the Automatic Distortion Factor Meter to monitor the receiver output level instead of a power meter an obvious saving in capital equipment cost is obtained.

For measurements made during development and type approval testing the manual Distortion Factor Meter, TF 2331, is generally better than the Automatic Distortion Factor Meter as it can be used for SINAD ratio measurements during adjacent channel selectivity tests. Details of this application will be found in the Marconi Instruments brochure "The Quiet Ones" which deals with the range of low noise signal generators for Mobile Radio Receiver testing.

Printed in England



Instruction Manual

No. EB 2337

for

Automatic Distortion Meter

TF 2337

1970

MARCONI INSTRUMENTS LIMITED

ST. ALBANS HERTFORDSHIRE ENGLAND

EB 2337
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Chapter 1

General information

1.1 INTRODUCTION

The TF 2337 is a solid state automatic distortion meter for accurate and quick measurement of the level and total distortion of audio-frequency signals.

By using F.E.T.'s in the input circuit, noise is considerably reduced and distortion measurements can be made for a signal as low as 3mV.

An L/C high-pass filter is used as the fundamental rejection filter for measurement of distortion. The measurement is not therefore affected by fundamental frequency variation caused by wow and flutter, which is usually present in domestic audio equipment.

The use of a ratio meter as a distortion meter avoids the necessity for 100% full scale calibration thus there is no need to set "reference" or "balance" controls. Level indication of this instrument can be read directly in terms of VOLTS and dB (0dB - 1V) and the distortion factor in terms of dB and PERCENTAGE. Operation is simplified to the extent that the operator has merely to select the appropriate range push button and read off the indication on the meter.

The TF 2337 is a small light-weight instrument having a good sensitivity of 3mV and because of the automatic fundamental rejection and metering facilities requires minimum operational adjustments thereby ensuring maximum simplicity and speed in use. The TF 2337 is therefore ideally suited to line volume testing of domestic equipment by skilled or unskilled operators.

1.2 DATA SUMMARY

Fundamental Frequency :

Range	400Hz ± 10% or 1kHz ± 10% using the internal filters 30Hz to 10kHz using external filter facility

TOTAL BANDWIDTH UPPER -3dB LIMIT NOMINALLY 100KcJs.

Distortion Measurement :

Range	4 ranges in 1 - 3 - 10 sequence from 0.3% to 30% full scale
Accuracy	Within ± 5% f.s.d. except where the input is less than 10mV on the 1% full scale range when the accuracy is better than ± 5% f.s.d.
Fundamental rejection	At least 56dB
Input requirements :	
Minimum	3mV (-50dB)
Maximum	30V (+30dB)

Level Measurement :

Range	8 ranges in 1 - 3 - 10 sequence from 10mV to 30V (-40 to +30dB) full scale
Frequency Response	20Hz to 50kHz ± 0.5dB (1kHz reference)
Accuracy	± 5% f.s.d. IN EACH RANGE.
Input Impedance :	100kΩ ± 10% unbalanced, Parallel capacity less than 50pF
Power Requirements :	100/115V or 200/230V A.C. 50/60Hz approx. 6VA

Dimensions and Weight	Height	Width	Depth	Weight
	200mm (7.95" approx)	270mm (10.6" approx)	250mm (9.85" approx)	6 kg (13¼ lb approx)

1.3 ACCESSORIES

Accessories supplied	Mains lead

Chapter 2

Operation

2.1 INSTALLATION

The Automatic Distortion Meter TF 2337 is available only for bench mounting. Normally set on four rubber feet, it can also be used in the tilted position by swinging the carrying handle forward and downwards thus providing an additional front support.

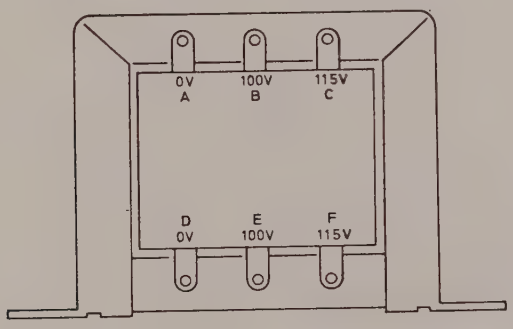
2.2 POWER SUPPLY

The socket of the mains lead supplied with this instrument fits into the plug on the rear panel. The other end of the lead must be fitted with a plug by the user. The three conductors are colour coded for this purpose, as follows:

COLOUR		CONNECTION
RED	BROWN	LIVE
BLACK or	BLUE	NEUTRAL
GREEN	GREEN/YELLOW	EARTH

To preserve the protective feature of the 3 pin mains plug when using a 2 pin mains outlet, use a 3 prong adaptor and ensure that the green wire is connected to an appropriate earth.

Before plugging into the mains check that the mains voltage settings are correct. The TF 2337 Automatic Distortion Meter requires a power source of 230V A.C. ± 10% 50/60Hz, but can be operated from any source of 100, 115, 200, 230 volts (±10%) at 50/60Hz by adjusting taps on the mains transformer primary as shown in the table below (Fig. 2.1).



VOLTAGE RANGE	SHORTING	TAPPING
90 ∽ 110V	A–D, B–E	A, B
104 ∽ 130V	A–D, C–F	A, C
180 ∽ 220	B–D	A, E
207 ∽ 253	C–D	A, F

Fig. 2.1 Mains transformer tappings

2.3 CONTROLS

(1) ON/OFF SWITCH. Pressing the switch up will switch on the instrument. Illumination of the indicator lamp will indicate that the supply has been switched on.

(2) INPUT TERMINALS. Consisting of two terminals forming SOCKET 1.

(3) FUNCTION SWITCH. Consisting of four push buttons, three used for the DISTORTION measuring function and the other for LEVEL measurments. When functioning in the DISTORTION mode the appropriate filter will also be selected.

(4) LEVEL RANGE SWITCH. Consisting of eight push buttons selection of the appropriate button will determine the full scale range of the LEVEL meter.

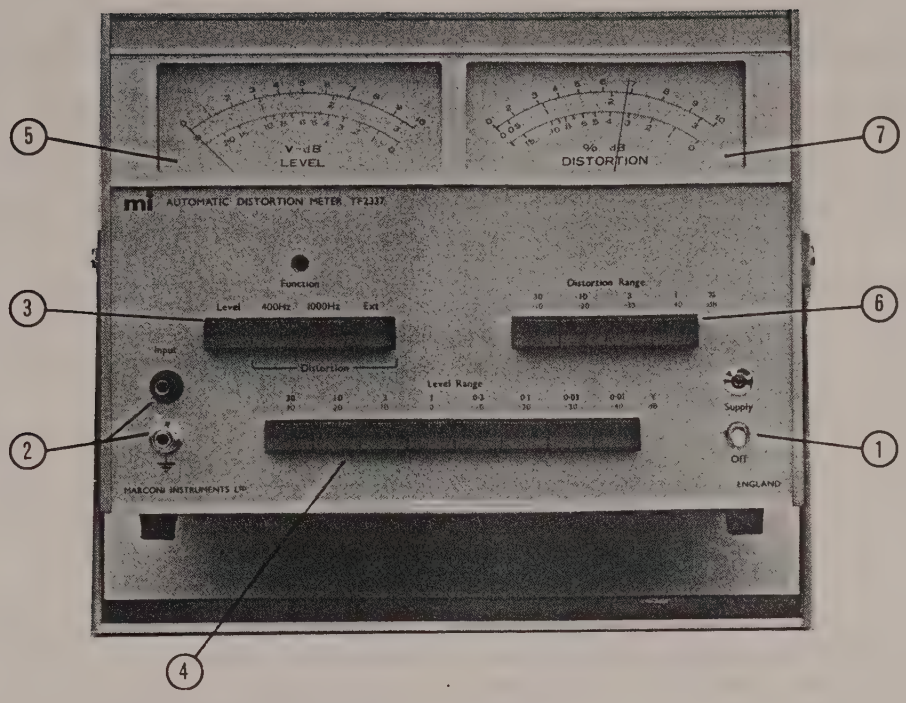


Fig. 2.2

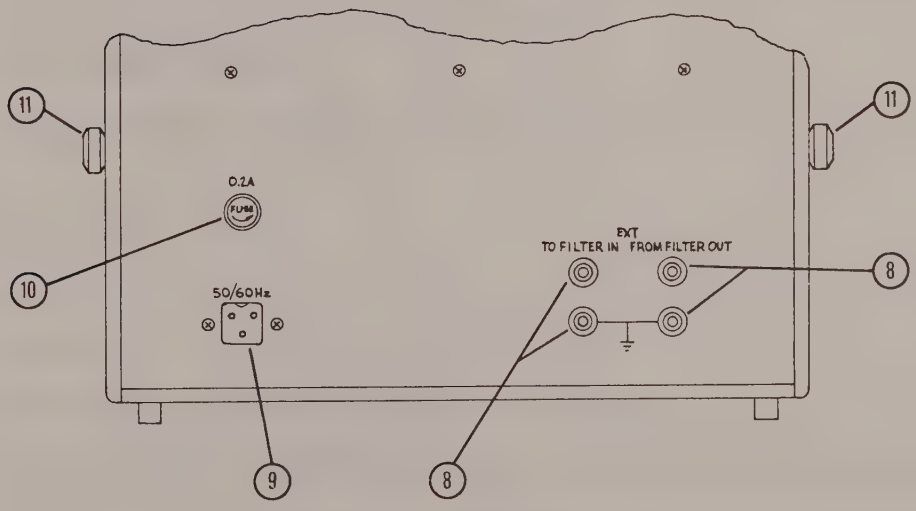
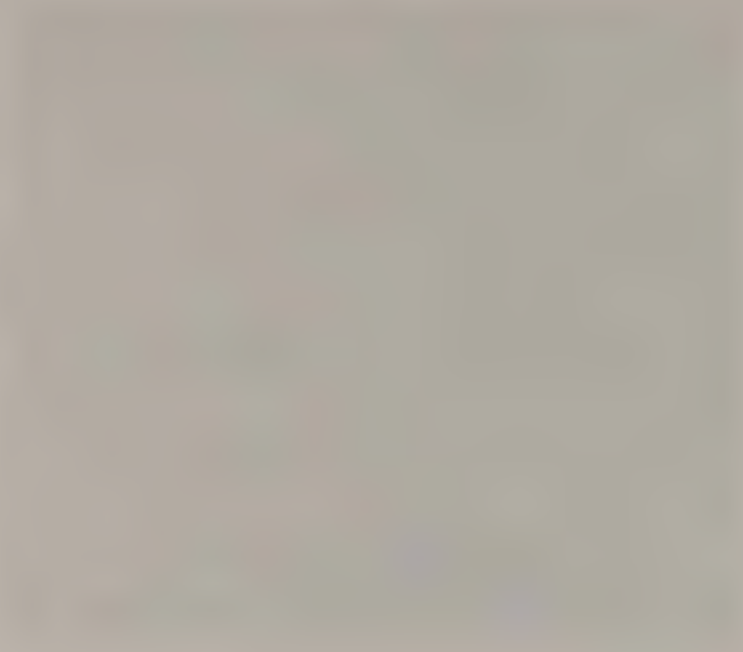


Fig. 2.3 Rear View



(5) LEVEL METER. Three scales, two calibrated in volts, the other in dB's (0dB = 1V)

(6) DISTORTION RANGE SWITCH. Consisting of four push buttons, selection of the appropriate button will determine the full scale range of the DISTORTION meter.

(7) DISTORTION METER. The meter has three scales - two calibrated in percentage and one in dB.

(8) EXT FILTER CONNECTIONS. Situated on the rear of instrument consisting of four terminals forming SOCKET 3 and SOCKET 4.

(9) SUPPLY PLUG. Accepts mains lead supplied.

(10) FUSE HOLDER

(11) RELEASE KNOB. A knurled screw which when rotated in the direction indicated releases the top and bottom sections of the casing.

2.4 PREPARATIONS FOR USE

The following instructions are intended as a detailed guide to the operation of the TF 2337 Automatic Distortion Meter. Continued use of these instructions will become unnecessary when familiarity with the instrument is achieved.

Before commencing measurements:

1) Ensure that the voltage tap on the mains transformer is set to the correct voltage.

2) Plug in the mains supply and switch on the instrument.
The Mains light should be on.

3) Check the mechanical Zero of the Level Meter and adjust if necessary by means of the screw positioned below the meter.

2.5 MEASUREMENT OF LEVEL

1) Select LEVEL on the FUNCTION switch

2) Select the 30V push button on the LEVEL RANGE switch.

3) Connect the signal to be measured to the INPUT terminal.

4) Observe the reading on the LEVEL METER, if this is not clear continue to select an alternative range on the LEVEL RANGE switch until the meter indication can be easily read.

When taking voltage readings the meter f.s.d. is determined by and indicated above the push button selected.

If a measurement is required in terms of dB's the signal level is indicated by (a) noting the dB's above the depressed LEVEL RANGE push button and adding this to (b) the dB reading indicated on the LEVEL METER. The meter indicates dB's down on the full scale reading.

i.e. if the 30dB push button on the LEVEL RANGE is depressed and the LEVEL meter indicates -5dB then the corrected reading is 25dB.

2.6 MEASUREMENT OF DISTORTION USING INTERNAL FILTER

1) Ensure that the LEVEL METER is reading between 0 and 10dB by pressing the appropriate push button on the LEVEL RANGE switch.

2) Select the appropriate filter by pressing the 400Hz or 1000Hz high pass filter on the FUNCTION switch.

3) Press the 30% push button on the DISTORTION RANGE switch and observe the reading on the DISTORTION METER. If the indication is difficult to read select the appropriate alternative push button on the DISTORTION RANGE switch.

In the case of measurement in terms of dB's the distortion level is determined by adding the dB's indicated immediately above the depressed push button on the DISTORTION RANGE switch and adding this to the dB's indicated on the DISTORTION METER. The meter indicates dB's down on the full scale reading.

i.e. if the -20dB push button on the DISTORTION RANGE is depressed and the DISTORTION METER indicates -10dB then the correct reading is -30dB.

2.7 MEASUREMENT OF DISTORTION USING AN EXTERNAL FILTER

Distortion measurements of alternative frequencies other than those covered by the built-in filters can be made by connecting an external filter across the EXT terminals SK3 and SK4 on the rear of the instrument. However if the accuracy of the instrument is to be maintained it is essential that the following conditions are met.

i) The input/output impedance of the filter must be 600Ω unbalanced.

ii) The insertion loss of the external filter must be determined and included in the indicated distortion measurement of the instrument (see Chapter 2.7.1 and 2.7.2).

The above conditions having been fulfilled, proceed as follows:

a) By pressing the appropriate push button on the LEVEL RANGE ensure that the LEVEL METER is reading between 0 and 10dB.

b) Press the 30% (-10dB) push button on the DISTORTION RANGE switch and observe the reading on the DISTORTION meter. If the indication is difficult to read select the appropriate alternative push button on the DISTORTION RANGE switch.

In the case of measurement in terms of dB's the distortion level is determined by noting the dB's indicated immediately above the depressed push button on the DISTORTION RANGE switch and adding this to the dB's indicated on the DISTORTION METER, remembering that the meter indicates dB's down on the full scale reading.

i.e. with -10dB indicated above the depressed push button and -10dB indicated on DISTORTION meter reading will be -20dB. Now correct this reading as described in Chapter 2.9.

2.8 METHOD OF DETERMINING INSERTION LOSS OF EXTERNAL FILTER

By using a measuring circuit as shown in Fig. 2.4 the filter characteristic and thus the insertion loss of the filter can be determined.

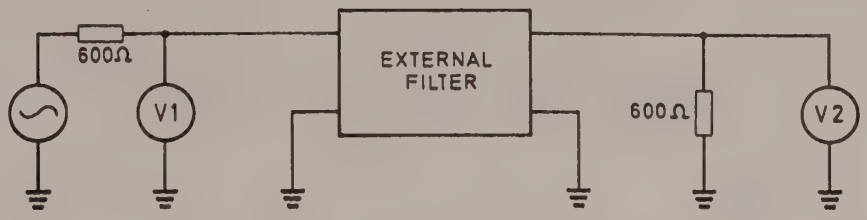


Fig. 2.4 Insertion loss measuring circuit

The characteristic must be as shown in Fig. 2.5.

NOTE:- The insertion loss of the built-in filters at 2.5fo is 1 dB.

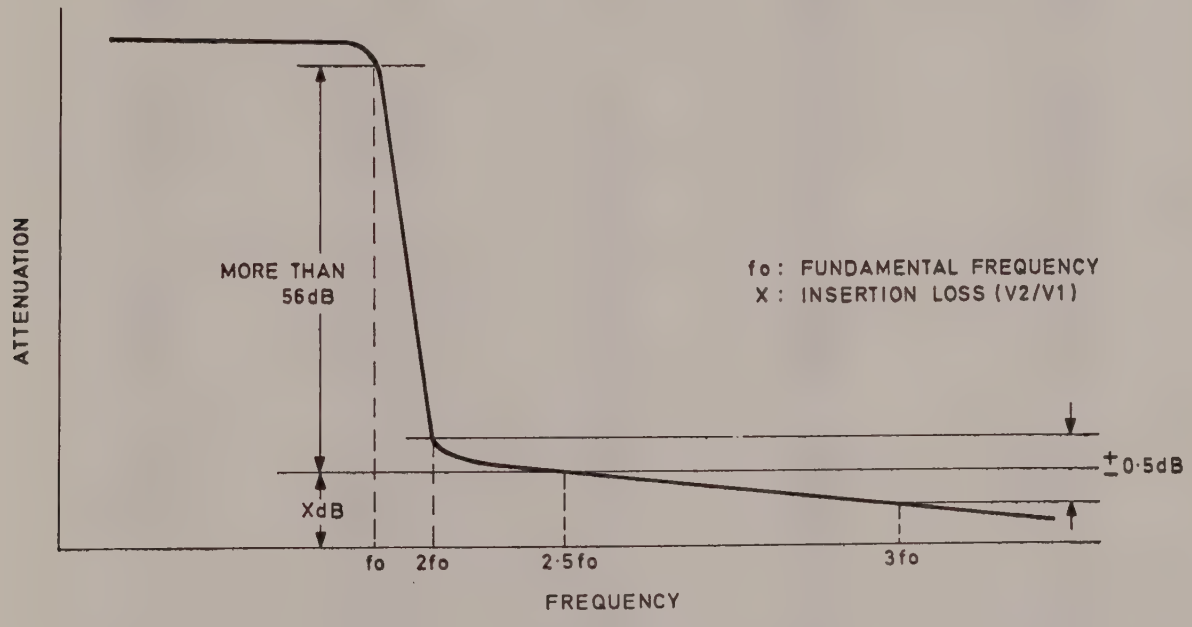


Fig. 2.5 Filter characteristic

2.9 CALCULATION OF DISTORTION USING EXTERNAL FILTER

Proceed as follows:

i) Note the indicated distortion as measured by the TF 2337.

ii) Subtract from this the insertion loss of the EXT filter.

Now since the insertion loss (1dB) of the built-in filter at 2.5fo has already been accounted for by adjustment of the DISTORTION meter scale it will be necessary to:-

iii) Increase the result of (i) and (ii) by 1dB.

i.e. If indicated distortion were 20dB
insertion loss of filter 4dB
Actual distortion would be 20 - 4 + 1 = 17dB

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	0	1·0	1·0
·9886	·9772	·1	1·012	1·023
·9772	·9550	·2	1·023	1·047
·9661	·9333	·3	1·035	1·072
·9550	·9120	·4	1·047	1·096
·9441	·8913	·5	1·059	1·122
·9333	·8710	·6	1·072	1·148
·9226	·8511	·7	1·084	1·175
·9120	·8318	·8	1·096	1·202
·9016	·8128	·9	1·109	1·230
·8913	·7943	1·0	1·122	1·259
·8710	·7586	1·2	1·148	1·318
·8511	·7244	1·4	1·175	1·380
·8318	·6918	1·6	1·202	1·445
·8128	·6607	1·8	1·230	1·514
·7943	·6310	2·0	1·259	1·585
·7762	·6026	2·2	1·288	1·660
·7586	·5754	2·4	1·318	1·738
·7413	·5495	2·6	1·349	1·820
·7244	·5248	2·8	1·380	1·905
·7079	·5012	3·0	1·413	1·995
·6683	·4467	3·5	1·496	2·239
·6310	·3981	4·0	1·585	2·512
·5957	·3548	4·5	1·679	2·818
·5623	·3162	5·0	1·778	3·162
·5309	·2818	5·5	1·884	3·548
·5012	·2512	6	1·995	3·981
·4467	·1995	7	2·239	5·012
·3981	·1585	8	2·512	6·310
·3548	·1259	9	2·818	7·943
·3162	·1000	10	3·162	10·000
·2818	·07943	11	3·548	12·59
·2512	·06310	12	3·981	15·85
·2239	·05012	13	4·467	19·95
·1995	·03981	14	5·012	25·12
·1778	·03162	15	5·623	31·62

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
·1585	·02512	16	6·310	39·81
·1413	·01995	17	7·079	50·12
·1259	·01585	18	7·943	63·10
·1122	·01259	19	8·913	79·43
·1000	·01000	20	10·000	100·00
·07943	·006310	22	12·59	158·5
·06310	·003981	24	15·85	251·2
·05012	·002512	26	19·95	398·1
·03981	·001585	28	25·12	631·0
·03162	·001000	30	31·62	1,000
·02512	·0006310	32	39·81	1,585
·01995	·0003981	34	50·12	2,512
·01585	·0002512	36	63·10	3,981
·01259	·0001585	38	79·43	6,310
·01000	·0001000	40	100·00	10,000
·007943	·00006310	42	125·9	15,850
·006310	·00003981	44	158·5	25,120
·005012	·00002512	46	199·5	39,810
·003981	·00001585	48	251·2	63,100
·003162	·00001000	50	316·2	100,000
·002512	$6{\cdot}310 \times 10^{-6}$	52	398·1	158,500
·001995	$3{\cdot}981 \times 10^{-6}$	54	501·2	251,200
·001585	$2{\cdot}512 \times 10^{-6}$	56	631·0	398,100
·001259	$1{\cdot}585 \times 10^{-6}$	58	794·3	631,000
·001000	10^{-6}	60	1,000	10^{6}
·0005623	$3{\cdot}162 \times 10^{-7}$	65	1,778	$3{\cdot}162 \times 10^{6}$
·0003162	10^{-7}	70	3,162	10^{7}
·0001778	$3{\cdot}162 \times 10^{-8}$	75	5,623	$3{\cdot}162 \times 10^{7}$
·0001000	10^{-8}	80	10,000	10^{8}
·00005623	$3{\cdot}162 \times 10^{-9}$	85	17,780	$3{\cdot}162 \times 10^{8}$
·00003162	10^{-9}	90	31,620	10^{9}
·00001000	10^{-10}	100	100,000	10^{10}
$3{\cdot}162 \times 10^{-6}$	10^{-11}	110	316,200	10^{11}
10^{-6}	10^{-12}	120	10^{6}	10^{12}
$3{\cdot}162 \times 10^{-7}$	10^{-13}	130	$3{\cdot}162 \times 10^{6}$	10^{13}
10^{-7}	10^{-14}	140	10^{7}	10^{14}

Chapter 3

Technical description

3.1 GENERAL SUMMARY

The TF 2337 Automatic Distortion Meter consists basically of three sections - Power Unit, Level Meter and Distortion Meter.

The Level Meter combines a 40dB and a 30dB (3 x 10dB steps) attenuator, providing level measurements in eight ranges.

The Distortion Meter using a 30dB (3 x 10dB steps) attenuator provides distortion measurement in four ranges.

The total signal is fed via attenuator, amplifier and rectifying stages through the level metering circuit to one side of a differential meter. The total signal is also extracted prior to the rectifying circuit, and fed to a high pass filter, the fundamental component being rejected. The remaining harmonic content is amplified then rectified and fed to the opposite side of the differential meter.

The differential meter (DISTORTION METER) suitably calibrated, resolves the two signals and in conjunction with the four distortion ranges indicates the DISTORTION FACTOR.

DISTORTION FACTOR is defined as:- $\sqrt{\frac{V_2^2 + V_3^2 + \ldots . V_n^2 + N^2}{V_1^2}} \times 100\%$

where V_1 = amplitude of fundamental

V_2, $V_3 \ldots V_n$ = amplitude of 2nd, 3rd ...nth harmonic

N = amplitude of noise and hum harmonic

However if the distortion factor is small, the error in measuring it as:-

$$\frac{V_2 + V_3 + \ldots . V_n + N}{V_1 + V_2 + V_3 \ldots . V_n + N} \times 100\%$$

is also small.

It is this latter quantity which is compared by the AUTOMATIC DISTORTION METER.

Operation of each stage can be explained with reference to the block schematic diagram Fig. 3.1.

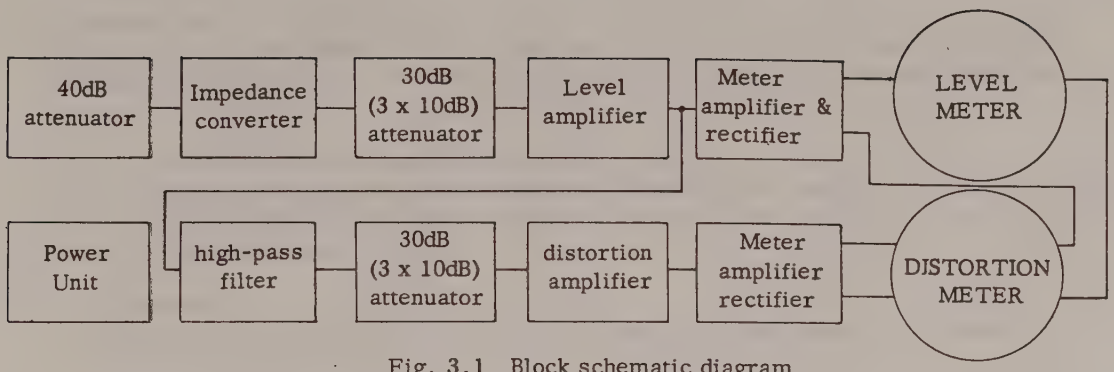


Fig. 3.1 Block schematic diagram

3.2 SYSTEMS OPERATION

3.2.1 40dB attenuator (S1a)

Input impedance is 100kΩ.
By using a 40dB attenuator, two ranges of input level are provided -0.3V and 30V.

3.2.2 Impedance Converter (Q101 and Q102)

Using F.E.T.'s with a high loop gain, 100% negative feedback is achieved thus the circuit has a high input and low output impedance.
Gain is 0dB.
D102 and D103 provide a protective feature against overloading.

3.2.3 (3 x 10dB step) 30dB attenuator (S1b)

The signal fed from the impedance converter can be attenuated by either 10, 20 or 30dB. Since this attenuator is coupled to the 40dB input attentuator the combination is effectively an eight x 10dB step level range with f.s.d. of 0.01V, 0.03V, 0.1V, 0.3V, 1.0V, 3.0V, 10V and 30 volts.

3.2.4 Level Amplifier (Q103, Q104 and Q105)

A 3 stage direct coupled amplifier; using an emitter follower in the last stage decreasing the output impedance; provides a gain of 40dB.
The gain can be adjusted by changing the feedback characteristics (R123 LEVEL GAIN).
The output from this stage is also fed to the high-pass filter.

3.2.5 Level Meter Amplifier & Rectifier (Q106, Q107, D104, D105)

The signal is amplified, rectified and displayed by the Level meter.
To improve linearity in the low voltage region of the diodes the output from D104 and D105 is fed back to the previous stage.

3.2.6 High Pass Filter

Two high pass L.C. filters are incorporated in the circuit - 400Hz and 1000Hz. "Lock-on" capability of the filters is within $\pm$ 10% of the stated fundamental.
The design of the filter is such that it has no effect on distortion measurement within the specified frequency limits.
To ensure that the automatic feature of the instrument is maintained the filters are designed to have an insertion loss of 1dB which is automatically taken into account by suitably adjusting the calibration of the DISTORTION Meter.

3.2.7 (3 x 10dB step) 30dB attenuator (S3)

Provides four ranges of distortion monitoring -

1% 3% 10% and 30%

3.2.8 Distortion Amplifier (Q108 and Q109)

With a gain of approximately 47dB this stage amplifies the harmonic content of the signal. The gain of this stage is adjusted by varying R146 (DIST GAIN) which changes the feedback characteristic.

3.2.9 Distortion-Meter Amplifier and Rectifier (Q110, Q111)

This circuit amplifies and rectifies the harmonic content of the signal.
The output from the rectifiers D106 and D107 is fed back to the previous stage to improve the low voltage region of the diodes.

3.2.10 Distortion Meter

A differential meter resolves the output signals and displays the result on a suitably calibrated scale.

Chapter 4

Maintenance

4.1 GENERAL

This section contains information for keeping the TF 2337 Automatic Distortion Meter in good working order and for checking its overall performance.

The equipment is aligned during manufacture and in general should not require re-alignment except following the replacement or repair of a component or sub-assembly.

4.2 ACCESS

Access to the instrument can be achieved by rotating the two knurled knobs on the side of the instrument in the direction indicated. The top and bottom panel sections will then be free for removal.

4.3 SCREW THREADS

Screw threads used on this instrument are I.S.O. Metric.

4.4 ALIGNMENT

The following procedure is offered as a guide to alignment and an indication of proper equipment operation.

Test equipment required for alignment is listed below:

a) Digital Voltmeter TF 2660 or equivalent.

b) Audio Frequency Oscillator TF 2103 or equivalent.

c) 11dB attenuator (see Chapter 4.3).

4.4.1 Adjustment of D.C. Voltage (Test equipment - a)

Remove top cover
With the Voltmeter connected to TP2, adjust R207 (24V ADJUST) for a reading of 24V $\pm$ 0.3V D.C.

4.4.2 Adjustment of Impedance Converter Bias (Test equipment - a)

Remove bottom cover.
With the Voltmeter connected to TP1, adjust R103 (BIAS ADJUST) for a reading of +10V $\pm$ 0.3V D.C.

4.4.3 Adjustment of Level Amplifier (Test equipment - b)

With the Audio Frequency Oscillator set to 1000Hz 1V (RMS) and the TF 2337 switched to LEVEL measurement on the 1V/0dB range adjust R123 (LEVEL GAIN) for a full scale reading on the LEVEL meter.

4.4.4 Adjustment of Distortion Amplifier

Connect a 600Ω unbalanced 11dB attenuator to the EXT terminals on the rear of the instrument. Function switch to LEVEL range 1V/0dB. Feed the 1000Hz signal to the TF 2337 and adjust the output of the Audio Freq. Oscillator until the Level Meter of the TF 2337 reads full scale. Depress the Function switch to EXT and the Distortion Range switch to 30%/-10dB and adjust R146 (DIST GAIN) so that the Distortion meter reads full scale.

4.5 METHOD OF FABRICATING THE 11dB ATTENUATOR

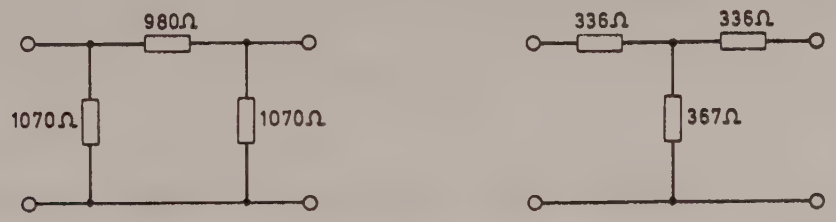


Fig. 4.1 11dB attenuator

Chapter 5

Repair

5.1 INTRODUCTION

This chapter contains information for the locating and repair of faults. Performance limits quoted are only for guidance and should not be taken as guaranteed performance specification unless they are also quoted in the Data Summary.

See Chapter 4 for information on access and screw fasteners.

5.2 FAULT LOCATION

Methodical fault location can be performed at the following three levels:

(i) Front panel functional checks for general location.
(ii) Internal checks for more detailed location.
(iii) Systematic calibration, which can be used to locate a fault for which methods (i) and (ii) are inadequate - See Chapter 4.

5.2.1 Front Panel Functional Checks

SYMPTOM	POSSIBLE FAULT LOCATION
With the input signal connected no reading on level or distortion	Check Q101 to Q105.
No level meter deflection.	Check Q106 and Q107.
No distortion meter deflection. (All Functions).	Check Q108 to Q111.
Insufficient +24 volts adjustment R207(+24V ADJ) measured at TP2	Check C201, C202, C205, D201, D202 and Q201 to Q203.
Insufficient bias adjustment with R103(BIAS ADJ) measured at TP1	Check D101, D102, D103 and Q101 to Q103.
Insufficient level gain adjustment with R123(LEVEL GAIN)	Check Q103 to Q107 and M1.
Insufficient distortion gain adjustment with R146 (DIST GAIN)	Check Q108 to Q111 and M2.

TABLE 5.1

5.2.2 Internal Checks

Having roughly located the fault by front panel checks more accurate locating can be achieved by taking D.C. voltage readings on the appropriate transistor. Table 5.2 gives the D.C. voltage checks. Incorrect voltage readings will generally indicate that the fault is with the transistor or with its associated circuit.

DC Voltage Checks

TRANSISTOR	E	B	C
Q 101	(S) 10.0V	(G) *	(D)20.5V
Q 102	21.2V	20.5V	10.0V
Q 103	1.0V	1.6V	5.6V
Q 104	4.9V	5.6V	14.3V
Q 105	13.6V	14.3V	24.0V
Q 106	2.5V	3.2V	17.7V
Q 107	18.5V	17.7V	14.0V
Q 108	0.9V	1.5V	6.0V
Q 109	5.3V	6.0V	12.7V
Q 110	2.5V	3.2V	17.7V
Q 111	18.5V	17.7V	14.0V
Q 201	24.6V	25.3V	38.0V
Q 202	24.0V	24.6V	38.0V
Q 203	8.5V	9.2V	25.3V
* Cannot be measured			

TABLE 5.2

As a further aid to localising the fault Table 5.3 gives the resistance measurement relative to ground on all printed circuit board pin connections.

PIN CONNECTOR NUMBER	FRONT PANEL SETTING		RESISTANCE
1	Level Range:*	0.01V 30V	600Ω
2			0Ω
3	Level Range:	1V 30V	1kΩ
		0.01V 0.3V	100kΩ
4			0Ω
5	Level Range:	0.01V, 1V	750Ω
		0.03V, 3V	190Ω
		0.1V, 10V	149Ω
		0.3V, 30V	143Ω
6	Function:	Level	380Ω
		400Hz	470Ω
		1000Hz	390Ω
		Ext	985Ω
7	Function:	Level	493Ω
		400Hz, Ext	1.8kΩ
		1000Hz	1.72kΩ
8			0Ω
13			0Ω
14	Distortion Range:	1%	600Ω
		3%	190Ω
		10%	149Ω
		30%	143Ω
15, 18			2.2kΩ
19			0Ω

TABLE 5.3

In case of difficulty, please contact the MARCONI SERVICE DIVISION (see address on back cover) or nearest representative, quoting the type and serial number on the data plate at the rear of the instrument. If the instrument is being returned for repair, please indicate clearly the nature of the fault or the work you require to be done.

5.3. PACKAGING FOR RESHIPMENT

In the event of the equipment being returned for servicing it should be packed in the original shipping carton and packing material. If this is not available wrap the instrument in heavy paper or plastic and place in a rigid outer box of wood, fibreboard or very strong corrugated cardboard. Use ample soft packing to prevent movement. Provide additional support for projecting parts to relieve these of unnecessary shock. Close the carton securely and seal with durable tape. Mark the shipping container FRAGILE to ensure careful handling.

Chapter 6

Replaceable parts

6.1 INTRODUCTION

This section lists replaceable parts in alphabetical - numerical order of their circuit references, with miscellaneous parts at the end of the list.

The following abbreviations and symbols are used:-

C	:	capacitor
CARB	:	carbon
D	:	semi conductor diode
ELECT	:	electrolytic
FS	:	fuse
FL	:	filter
LP	:	indicator lamp
M	:	meter
MET	:	metal
PL	:	plug
PLAS	:	plastic
Q	:	transistor
R	:	resistor
VAR	:	variable
S	:	switch
SK	:	socket
T	:	transformer
WW	:	wirewound
W	:	watt

6.2 ORDERING

When ordering replacements or spare parts, address the order to:

Service Division,
Hedley Road,
St. Albans,
Herts.

or to your nearest representative. Please specify the following information for each part required:

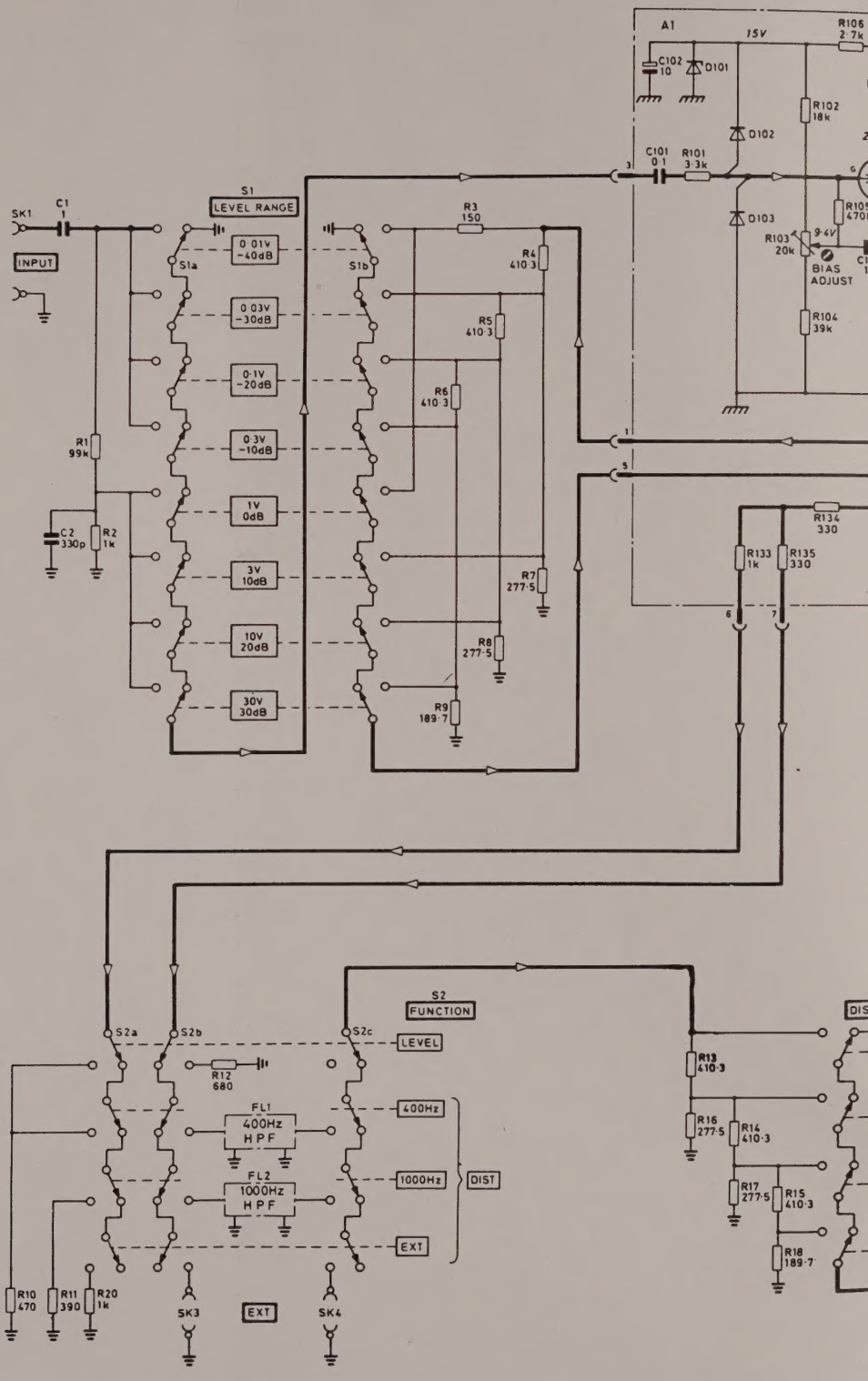
1) Type of instrument
2) Circuit reference
3) Description
4) M.I. Drawing Number

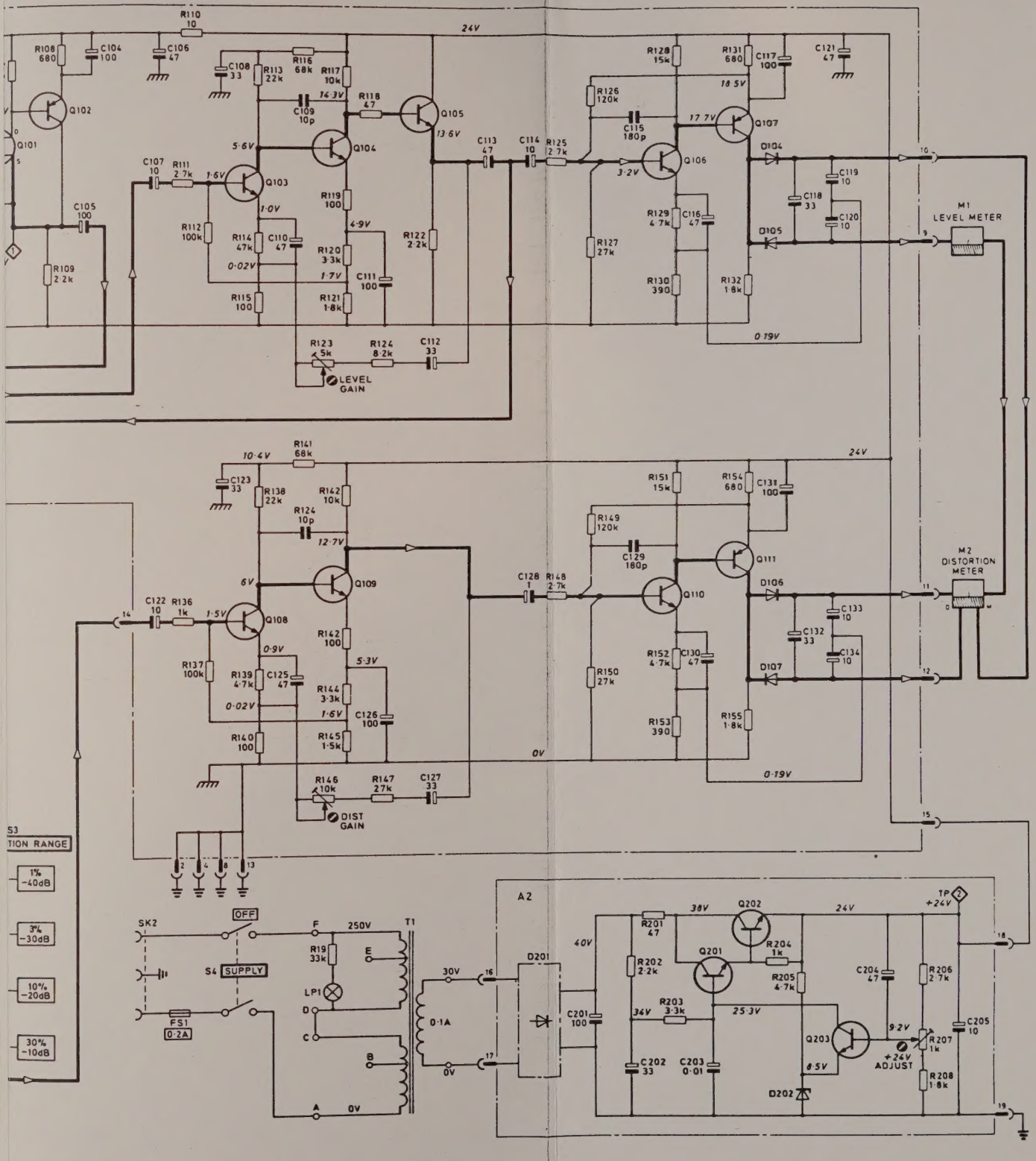
Circuit reference	Description	M.I. Part No.
Capacitors -		
C1	PAPER 1uF ± 20% 250V	FPP/MPT25T-1A
C2	MICA 330pF ± 10% 300V	FPP/CM15YB331K3
Filters -		
FL1	FILTER 400Hz	FPP/SES-M12512
FL2	FILTER 1000Hz	FPP/SES-M12513
Fuse -		
FS1	FUSE, GLASS 0.2A	FPP/SM-1001/20
Lamp -		
LP1	LAMP, NEON	FPP/BNA-3
Meters -		
M1	METER DC1mA	FPP/SES-M12510
M2	METER, DIFFERENTIAL	FPP/SES-M12511
Resistors -		
R1	MET. FILM 99kΩ ± 0.5% ¼W	FPP/RN60J99KD
R2	MET. FILM 1kΩ ± 0.5% ¼W	FPP/RN60J1KD
R3	CARB. FILM 150Ω ± 5% ¼W	FPP/HES1/4150J
R4	MET. FILM 410.3Ω ± 0.5% ¼W	FPP/RN60J410.3D
R5	MET. FILM 410.3Ω ± 0.5% ¼W	FPP/RN60J410.3D
R6	MET. FILM 410.3Ω ± 0.5% ¼W	FPP/RN 60J410.3D
R7	MET. FILM 277.5Ω ± 0.5% ¼W	FPP/RN60J277.5D
R8	MET. FILM 277.5Ω ± 0.5% ¼W	FPP/RN60J277.5D
R9	MET. FILM 189.7Ω ± 0.5% ¼W	FPP/RN60J189.7D
R10	CARB. FILM 470Ω ± 5% ¼W	FPP/HES1/4470J
R11	CARB. FILM 390Ω ± 5% ¼W	FPP/HES1/4390J
R12	CARB. FILM 680Ω ± 5% ¼W	FPP/HES1/4680J
R13	MET. FILM 410.3Ω ± 0.5% ¼W	FPP/RN60J410.3D
R14	MET. FILM 410.3Ω ± 0.5% ¼W	FPP/RN60J410.3D
R15	MET. FILM 410.3Ω ± 0.5% ¼W	FPP/RN60J410.3D
R16	MET. FILM 277.5Ω ± 0.5% ¼W	FPP/RN60J277.5D
R17	MET. FILM 277.5Ω ± 0.5% ¼W	FPP/RN60J277.5D
R18	MET. FILM 189.7Ω ± 0.5% ¼W	FPP/RN60J189.7D
R19	CARB. FILM 33kΩ ± 5% ¼W	FPP/HES1/433KJ
R20	CARB. FILM 1kΩ ± 5% ¼W	FPP/HES1/41KJ
Switches -		
S1	8 way - Push button (Level Range)	FPP/SES-M12494
S2	4 way - Push button (Function)	FPP/SES-M12495
S3	4 way - Push button (Distortion range)	FPP/SES-M12496
S4	Toggle	FPP/S - 2022
Sockets -		
SK1	INPUT (see terminals)	FPP/S-16905
SK2	MAINS	
SK3	EXT FILTER (see terminals)	
SK4	EXT FILTER (see terminals)	

Circuit reference	Description		M.I. Part No.
Transformer -			
T1	TRANSFORMER		FPP/SES-M12894
Capacitors -			
C101	PLAS 0.1μF ± 20% 100V		FPP/SW-1P1
C102	ELECT 10μF + 100% - 10% 25V		FPP/25TH10
C103	ELECT 10μF + 100% - 10% 10V		FPP/10TH10
C104	ELECT 100μF + 100% - 10% 6.3V		FPP/6.3TK100
C105	ELECT 100μF + 100% - 10% 16V		FPP/16TK100
C106	ELECT 47μF + 100% - 10% 25V		FPP/25TK47
C107	ELECT 10μF + 100% - 10% 10V		FPP/10TH10
C108	ELECT 33μF + 100% - 10% 16V		FPP/16TH33
C109	MICA 180pF ± 10% 300V		FPP/CM15YB181K
C110	ELECT 47μF + 100% - 10% 6.3V		FPP/6.3TH47
C111	ELECT 100μF + 100% - 10% 10V		FPP/10TK100
C112	ELECT 33μF + 100% - 10% 16V		FPP/16TH33
C113	ELECT 47μF + 100% - 10% 16V		FPP/16TH47
C114	ELECT 10μF + 100% - 10% 6.3V		FPP/6.3TH10
C115	MICA 180pF ± 10% 300V		FPP/CM15YB181K3
C116	ELECT 47μF + 100% - 10% 6.3V		FPP/6.3TH47
C117	ELECT 100μF + 100% - 10% 6.3V		FPP/6.3TH100
C118	ELECT 33μF + 100% - 10% 6.3V		FPP/6.3TH33
C119	ELECT 10μF + 100% - 10% 16V		FPP/16TH10
C120	ELECT 10μF + 100% - 10% 16V		FPP/16TH10
C121	ELECT 47μF + 100% - 10% 25V		FPP/25TK47
C122	ELECT 10μF + 100% - 10% 6.3V		FPP/6.3TH10
C123	ELECT 33μF + 100% - 10% 16V		FPP/16TH33
C124	MICA 10pF ± 10% 300V		FPP/CM15YB100K3
C125	ELECT 47μF + 100% - 10% 6.3V		FPP/6.3TH47
C126	ELECT 100μF + 100% - 10% 10V		FPP/10TK100
C127	ELECT 33μF + 100% - 10% 16V		FPP/16TH33
C128	ELECT 1μF + 100% - 10% 16V		FPP/16TH1
C129	MICA 180pF ± 10% 300V		FPP/CM15YB181K3
C130	ELECT 47μF + 100% - 10% 6.3V		FPP/6.3TH47
C131	ELECT 100μF + 100% - 10% 6.3V		FPP/6.3TH300
C132	ELECT 33μF + 100% - 10% 6.3V		FPP/6.3TH33
C133	ELECT 10μF + 100% - 10% 16V		FPP/16TH10
C134	ELECT 10μF + 100% - 10% 16V		FPP/16TH10
Diodes -			
D101	ZENER	RD16A	FPP/RD16A
D102	SILICON	1S1473	FPP/1S1588
D103	SILICON	1S1473	FPP/1S1588
D104	SILICON	1S1473	FPP/1S1588
D105	SILICON	1S1473	FPP/1S1588
D106	SILICON	1S1473	FPP/1S1588
D107	SILICON	1S1473	FPP/1S1588
Transistors -			
Q101	N channel FET		FPP/2SK13
Q102	PNP Silicon		FPP/2SA495
Q103	NPN Silicon		FPP/2SC373
Q104	NPN Silicon		FPP/2SC373
Q105	NPN Silicon		FPP/2SC373

Circuit description	Description	M.I. Part No.
Q106	NPN Silicon	FPP/2SC372
Q107	PNP Silicon	FPP/2SA495
Q108	NPN Silicon	FPP/2SC373
Q109	NPN Silicon	FPP/2SC373
Q110	NPN Silicon	FPP/2SC372
Q111	PNP Silicon	FPP/2SA495
Resistors -		
R101	CARB. FILM 3.3kΩ ± 5% ¼W	FPP/HES1/43.3KJ
R102	CARB. FILM 18kΩ ± 5% ¼W	FPP/HES1/418KJ
R103	VAR.W.W. 20kΩ	FPP/L13T20KB
R104	CARB. FILM 39kΩ ± 5% ¼W	FPP/HES1/439KJ
R105	CARB. FILM 470kΩ ± 5% ¼W	FPP/HES1/4470KJ
R106	CARB. FILM 2.7kΩ ± 5% ¼W	FPP/HES1/42.7KJ
R107	CARB. FILM 6.8kΩ ± 5% ¼W	FPP/HES1/46.8KJ
R108	CARB. FILM 680Ω ± 5% ¼W	FPP/HES1/4680J
R109	CARB. FILM 2.2kΩ ± 5% ¼W	FPP/HES1/42.2KJ
R110	CARB. FILM 10Ω ± 5% ¼W	FPP/HES1/410J
R111	CARB. FILM 2.7kΩ ± 5% ¼W	FPP/HES1/42.7KJ
R112	CARB. FILM 100kΩ ± 5% ¼W	FPP/HES1/4100KJ
R113	CARB. FILM 22kΩ ± 5% ¼W	FPP/HES1/422KJ
R114	CARB. FILM 4.7kΩ ± 5% ¼W	FPP/HES1/44.7KJ
R115	CARB. FILM 100Ω ± 5% ¼W	FPP/HES1/4100J
R116	CARB. FILM 68kΩ ± 5% ¼W	FPP/HES1/468KJ
R117	CARB. FILM 10kΩ ± 5% ¼W	FPP/HES1/410KJ
R118	CARB. FILM 47Ω ± 5% ¼W	FPP/HES1/447J
R119	CARB. FILM 100Ω ± 5% ¼W	FPP/HES1/4100J
R120	CARB. FILM 3.3kΩ ± 5% ¼W	FPP/HES1/43.3KJ
R121	CARB. FILM 1.8kΩ ± 5% ¼W	FPP/HES1/42.8KJ
R122	CARB. FILM 2.2kΩ ± 5% ¼W	FPP/HES1/42.2KJ
R123	VAR.CARB. 5kΩ	FPP/RV16YP10S5KB
R124	CARB. FILM 8.2kΩ ± 5% ¼W	FPP/HES1/48.2KJ
R125	CARB. FILM 2.7kΩ ± 5% ¼W	FPP/HES1/42.7KJ
R126	CARB. FILM 120kΩ ± 5% ¼W	FPP/HES1/4120KJ
R127	CARB. FILM 27kΩ ± 5% ¼W	FPP/HES1/427KJ
R128	CARB. FILM 15kΩ ± 5% ¼W	FPP/HES1/415KJ
R129	CARB. FILM 4.7kΩ ± 5% ¼W	FPP/HES1/44.7KJ
R130	CARB. FILM 390Ω ± 5% ¼W	FPP/HES1/4390J
R131	CARB. FILM 680Ω ± 5% ¼W	FPP/HES1/4680J
R132	CARB. FILM 1.8kΩ ± 5% ¼W	FPP/HES1/41.8KJ
R133	CARB. FILM 1kΩ ± 5% ¼W	FPP/HES1/41KJ
R134	CARB. FILM 330Ω ± 5 % ¼W	FPP/HES1/4330J
R135	CARB. FILM 330Ω ± 5% ¼W	FPP/HES1/4330J
R136	CARB. FILM 1kΩ ± 5% ¼W	FPP/HES1/41KJ
R137	CARB. FILM 100kΩ ± 5% ¼W	FPP/HES1/4100KJ
R138	CARB. FILM 22kΩ ± 5% ¼W	FPP/HES1/422KJ
R139	CARB. FILM 4.7kΩ ± 5% ¼W	FPP/HES1/44.7KJ
R140	CARB. FILM 100Ω ± 5% ¼W	FPP/HES1/4100J
R141	CARB. FILM 68kΩ ± 5% ¼W	FPP/HES1/468KJ
R142	CARB. FILM 10kΩ ± 5% ¼W	FPP/HES1/410KJ
R143	CARB. FILM 100Ω ± 5% ¼W	FPP/HES1/4100J
R144	CARB. FILM 3.3kΩ ± 5% ¼W	FPP/HES1/43.3KJ
R145	CARB. FILM 1.5kΩ ± 5% ¼W	FPP/HES1/41.5KJ
R146	VAR.CARB.10kΩ	FPP/RV16YP10S10KB
R147	CARB. FILM 27kΩ ± 5% ¼W	FPP/HES1/427KJ
R148	CARB. FILM 2.7kΩ ± 5% ¼W	FPP/HES1/42.7KJ
R149	CARB. FILM 120kΩ ± 5% ¼W	FPP/HES1/4120KJ
R150	CARB. FILM 27kΩ ± 5% ¼W	FPP/HES1/427KJ

Circuit reference	Description		
Resistors (continued) -			
R151	CARB. FILM 15kΩ ± 5% ¼W		FPP/HES1/415KJ
R152	CARB. FILM 4.7kΩ ± 5% ¼W		FPP/HES1/44.7KJ
R153	CARB. FILM 390Ω ± 5% ¼W		FPP/HES1/4390J
R154	CARB. FILM 680Ω ± 5% ¼W		FPP/HES1/4680J
R155	CARB. FILM 1.8kΩ ± 5% ¼W		FPP/HES1/41.8KJ
Capacitors -			
C201	ELECT 100μF + 100% - 10% 50V		FPP/50TA100
C202	ELECT 33μF + 100% - 10% 50V		FPP/50TK33
C203	PLAS 0.01μF ± 20% 100V		FPP/SW-1S1
C204	ELECT 47μF + 100% - 10% 16V		FPP/16TH47
C205	ELECT 10μF + 100% - 10% 25V		FPP/25TH10
Diodes -			
D201	DIODE STACK	500mA	FPP/4D01
D202	ZENER	7.5V to 10.0V 200mA	FPP/RD9A
Transistors -			
Q201	NPN Silicon		FPP/2SC284
Q202	NPN Silicon		FPP/2SD150
Q203	NPN Silicon		FPP/2SC284
Resistors -			
R201	CARB. FILM 47Ω ± 5% ¼W		FPP/HES1/447J
R202	CARB. FILM 2.2kΩ ± 5% ¼W		FPP/HES1/42.2KJ
R203	CARB. FILM 3.3kΩ ± 5% ¼W		FPP/HES1/43.3KJ
R204	CARB. FILM 1kΩ ± 5% ¼W		FPP/HES1/41KJ
R205	CARB. FILM 4.7kΩ ± 5% ¼W		FPP/HES1/44.7KJ
R206	CARB. FILM 2.7kΩ ± 5% ¼W		FPP/HES1/42.7KJ
R207	VAR.W.W.	1kΩ	FPP/L-13T1KB
R208	CARB. FILM 1.8kΩ ± 5% ¼W		FPP/HES1/41.8KJ
Mechanical Parts			
Terminals -			
	Output terminal (Part of SK1)		FPP/D113001-3
	Output terminal earth (Part of SK1)		FPP/D113004-6
	Ext. Filter terminal (Part of SK3)		FPP/D113001-3
	Ext. Filter terminal earth (Part of SK3)		FPP/D113004-6
	Ext. Filter terminal (Part of SK4)		FPP/D113001-3
	Ext. Filter terminal earth (Part of SK4)		FPP/D113004-6
	Handle Arm		FPP/3602002
	Handle parts		FPP/3605002
			FPP/3605004
	Handle fixing nut		FPP/3605003
	Handle indexing mechanism		FPP/3610001
	Rubber leg		FPP/3611001


A1
15V
R106
2·7k
C102
10
D101
R102
18k
D102
C101
0·1
R101
3·3k
D103
R103
20k
9·4V
BIAS
ADJUST
R104
39k
S1
LEVEL RANGE
SK1
C1
1
INPUT
S1a
S1b
0·01V
-40dB
0·03V
-30dB
0·1V
-20dB
0·3V
-10dB
1V
0dB
3V
10dB
10V
20dB
30V
30dB
R1
99k
C2
330p
R2
1k
R3
150
R4
410·3
R5
410·3
R6
410·3
R7
277·5
R8
277·5
R9
189·7
R134
330
R133
1k
R135
330
S2
FUNCTION
S2a
S2b
S2c
LEVEL
R12
680
FL1
400Hz
H P F
400Hz
FL2
1000Hz
H P F
1000Hz
DIST
EXT
R10
470
R11
390
R20
1k
SK3
EXT
SK4
R13
410·3
R16
277·5
R14
410·3
R17
277·5
R15
410·3
R18
189·7



TF 2337 AUTOMATIC DISTORTION METER

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